tinsley
PRECISION INSTRUMENTS

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INS-5005kV

5 kV digital insulation tester

User guide

INS-5005kV

5 kV digital insulation tester

User guide

GF-2132

Safety warnings

- Before to use this instrument the User guide and Safety warnings must be read and understood
- Safety procedures and rules for working near high voltage energized systems must be observed during the use of this equipment. The generated voltages may be dangerous
- Do not connect or disconnect the test leads during the measurement
- Do not touch the test leads before the high voltage indicator turn-off
- Be careful not to make short-circuit between the high voltage terminals and the “R” or “Guard” terminals while a measurement is running, because it could be dangerous for the operator
- Be sure that there are not any voltage difference between the points to which the equipment will be connected to, neither between them and ground
- The panel, terminals and connectors of the equipment must stay dry and clean
- Use only accessories / replacement parts provided by the manufacturer

This equipment should be used only by a trained and competent person, strictly applying suitable safety rules.

Used symbols

	Caution, risk of electric shock.
	Caution, refer to User Guide.
CE	Equipment complies with current EU Directives.
	Battery
	Printer
	Printer paper feed
	USB (Universal Serial Bus)
	Backlight
	30V MAX: indicates the maximum voltage permitted between the terminals.
	Do not use in distribution systems with voltage higher than 660 V (phase to phase)
CAT III	Measuring category III
	Double insulation: this symbol indicates that the equipment is classified as Class II, double insulation.
	The rubbish bin with a line through it means that in the European Union, the product must undergo selective disposal for the recycling of electric and electronic material, in compliance with Directive WEEE 2002/96/EC.

Measurement Categories (CAT)

CAT II
Corresponds to measurements taken on circuits directly connected to low-voltage installations.

CAT III
Corresponds to measurements on building installations.

CAT IV
Corresponds to measurements taken at the source of low-voltage installations.

Index

1. Description

The **Tinsley INS-5005kV** is a smart, microprocessor-controlled, 5 kV insulation tester and analyzer. Besides the conventional measurement of insulation resistances up to 5 TΩ, its advanced features allow to automatically measure both the Polarization Index and Dielectric Absorption Index, thus significantly simplifying testing of transformers.

This insulation tester is portable, battery-powered equipment. Test voltage may be chosen from 500 V to 5 kV in 100 V increments. Due to its measurement principle (actual voltage and current readings) the accuracy of resistance measurement is not affected by any test voltage error.

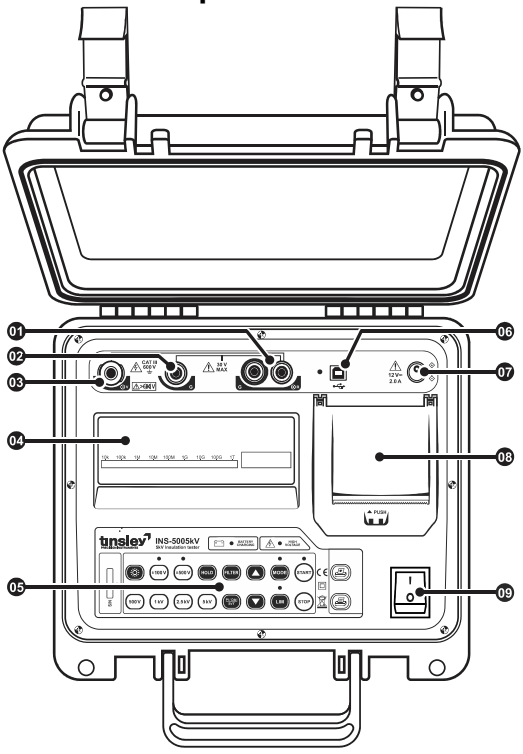
The built-in chronometer automatically counts the elapsed time since the start of measurement. Measured values are transmitted through the data output (USB) and are printed in the built-in printer as a registration of the performed test. Furthermore, the measured values are stored in a non-volatile internal memory. Up to 4000 measured values may be stored, to be transferred afterwards to a computer running the Tinsley Software program. This software allows a further analysis of the test results, including a graphical representation and automatic report generation. The real time clock and calendar, and the sequential test number, facilitates the identification of each test, and the organization of a predictive maintenance system by trend analysis.

Some other advanced features are useful to run the most sophisticated insulation analysis. Step Voltage Test, configurable Pass-Fail and timed measurements are automatically performed, with a very simple and user-friendly setup. The measurement parameters are stored in the non-volatile memory for an easy configuration.

The cabinet is strong and lightweight, easy to carry, impact-resistant and suitable to be used under severe weather conditions. Thus the insulation tester supplies very reliable and accurate measurements both in laboratory and out in the field.

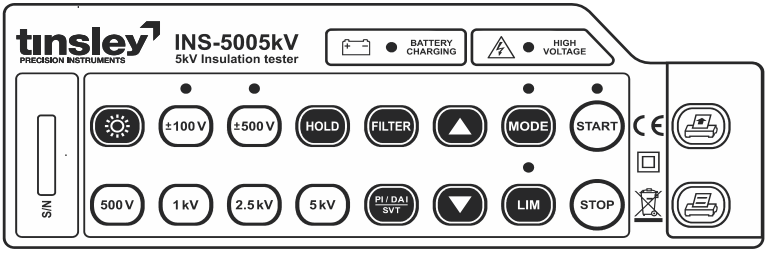
2. Control panel functions

2.1. Connections and panel items



01 Zero reference terminal (+R)
02 Guard terminal (G)
03 Voltage output terminal (-V)
04 Display
05 Keyboard
06 USB communication port
07 Power supply input
08 Thermal printer
09 On/Off switch

2.2. Keyboard

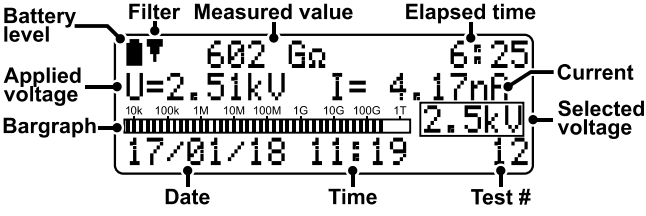


Button	Function	LED
	Backlight - activates the display light	-
FILTER	It activates the filter that minimizes external noise interference.	-
HOLD	Hold - freeze the last reading on the display.	-
PI / DAI SVT	Shows the calculated value on the display as a result of a Step Voltage Test (SVT), Polarization Index (PI) and Dielectric Absorption Index (DAI)	-
±500 V	When activated, it allows to program test voltage in steps of 500 V. It enables the fast voltage selection keys 500 V 1 kV 2.5 kV 5 kV.	500 V steps test voltage.
±100 V	When activated, it allows to program test voltage in steps of 100 V. It enables the fast voltage selection keys 500 V 1 kV 2.5 kV 5 kV.	100 V steps test voltage.
500 V	Fast selection of 500 V test voltage.	-
1 kV	Fast selection of 1 kV test voltage.	-
2.5 kV	Fast selection of 2.5 kV test voltage.	-
5 kV	Fast selection of 5 kV test voltage.	-

MODE	When activated, it allows to program the Operation Mode (Normal, SVT1, SVT2 or TIMER).	Indicates Operation Mode is enabled.
LIM	When activated, it allows to program the limit of the “Pass-Fail test”.	Indicates LIM function is activated.
	Turns On/Off the printer.	The printer is activated.
	Paper feed – used to change the paper reel.	-
	Increase the value that is being programmed.	-
	Decrease the value that is being programmed.	-
START	Starts the test.	Indicates that the test is being carried out.
STOP	End of test.	-

2.3. Display

Alphanumeric LCD where the measurement result, the corresponding measuring unit, the elapsed time since the measurement started, the analogue indication by means of a bargraph and messages to the operator are displayed (in English).



2.4. High voltage indicator

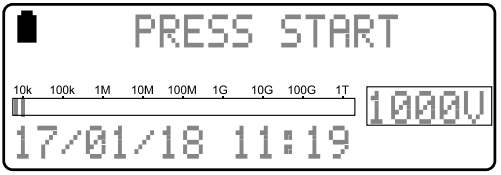
A light indicator warns the occurrence of high voltage on the output terminal during the measurement and keeps lit until the discharging process has been completed.

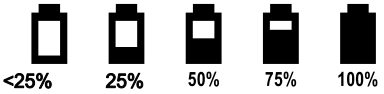
3. Power supply

This equipment is powered by an internal rechargeable LFP battery (LiFePO4 12 V - 3000 mAh) or mains supply (through the AC Adapter).

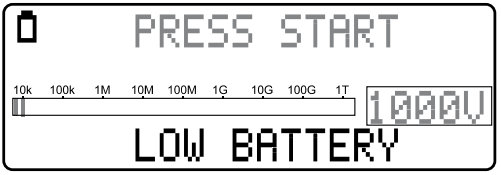
3.1. Battery status

The battery level is indicated by an icon located at the top-left corner of display.





If the battery has less than 20% charge, the message LOW BATTERY will start blinking in the display.



3.2. Battery charger

This equipment has an intelligent built-in circuit that controls the battery charge. In order to charge the battery, follow this procedure:

- Verify that the **On/Off** switch is switched off .
- Connect the equipment into the mains supply (using the supplied AC Adapter). The charging indicator (BATTERY CHARGING) will turn-on red and will remain that way until the battery is totally charged. Then the light will remain green and keep in that way until the equipment is disconnected of the mains supply.

The following chart summarizes the meaning of LED luminous indications:

Green and red flashing alternatively	Test of the initial condition of the battery when plugging the mains, during one second.
Permanent red	Battery under charge.
Flashing red	Charging current is less than normal.
Permanent green	The charging process has been successfully finished. Battery OK.
Flashing green	The charging process has finished, nevertheless the battery hasn't received the complete charge.

⚠ Use only the AC Adapter provided by the manufacturer. The use of any other AC Adapter may compromise the equipment safety.

The rechargeable battery does not have "memory effect" and there are no restrictions to start charging it as many times as is needed. However the battery could be damaged if remains in deep discharge for a while. To avoid this effect, charge the battery before left the equipment in storage and don't let pass more than 30 days without recharge, even if the instrument wasn't used (under storage, the battery loses part of its charge).

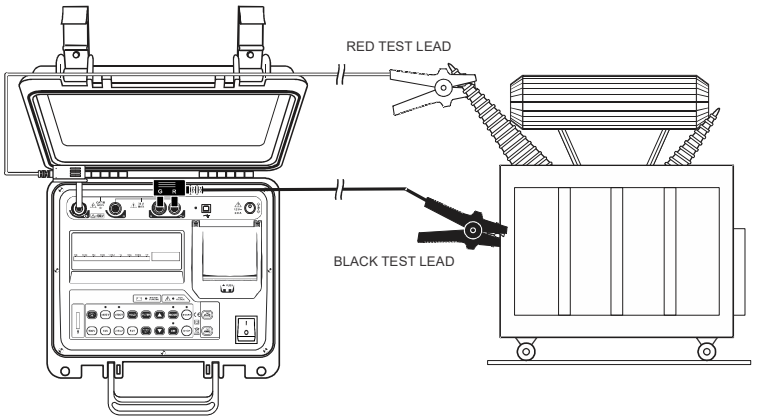
4. Connecting the equipment

ATTENTION: For a safety operation the procedures detailed below should be carried out with the device Powered-Off.

Check if there is no differences of potential voltage between the points where the equipment shall will be connected to, nor between them and the ground.

⚠ Use only the accessories / test leads supplied by the manufacturer. Using accessories / test leads not provided by the manufacturer may compromise the equipment safety.

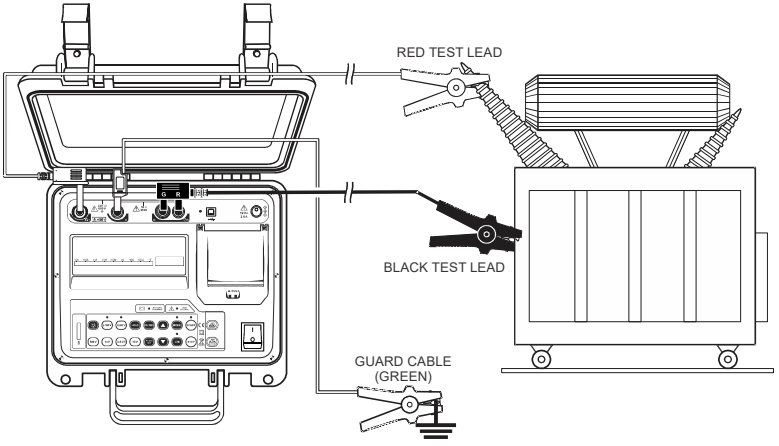
Connect the red security terminal (red cable) to the insulation tester (-V) output terminal. Connect the black test lead to the zero reference (+R) terminal and the “alligators” terminals to the element to be measured as indicated in the figure below.



The test leads in the picture are illustrative.

4.1. Using the Guard terminal

The G (Guard) terminal can be used or not, according to the measurement that is going to be carried out. During measurements, the equipment must be electrically referred to earth in order prevent the equipment from being on a high potential, which may produce unstable readings. When insulation is measured regarding grounding, the **R** terminal is connected to earth and the condition by means of which the equipment potential setting is fulfilled. If the measurement is performed between two parts, which are not grounded (for example, between two phase conductors in a tree-phase cable), the insulation tester Guard terminal must be grounded. This implies that **whenever a measurement is performed, one of the GUARD or R terminals must be grounded, but not both of them simultaneously.**

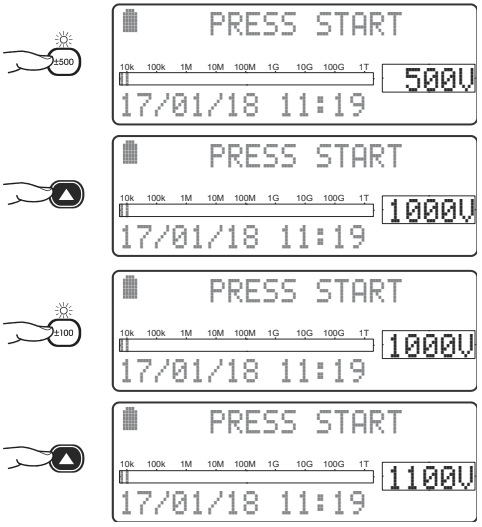


The Application Note 32 explains the usage of Guard terminal for minimizing the parasite resistance effect, whose influence one intends to minimize.

5. Tests definition

5.1. Test voltage definition

In order to define the test voltage value, first it is necessary to select one of voltage adjustment keys: ±100 V or ±500 V. These keys enable both the pre-programmed voltage selection (500 V 1 kV 2.5 kV 5 kV) and the ▲ and ▼ keys which increase or decrease the value of the step voltage test for 100 V or 500 V, depending on the selected voltage adjustment key. As long as the equipment is on, the voltage adjustment key ±500 V will be selected. Press again the adjustment key selected at the moment to leaving the test voltage selection mode.



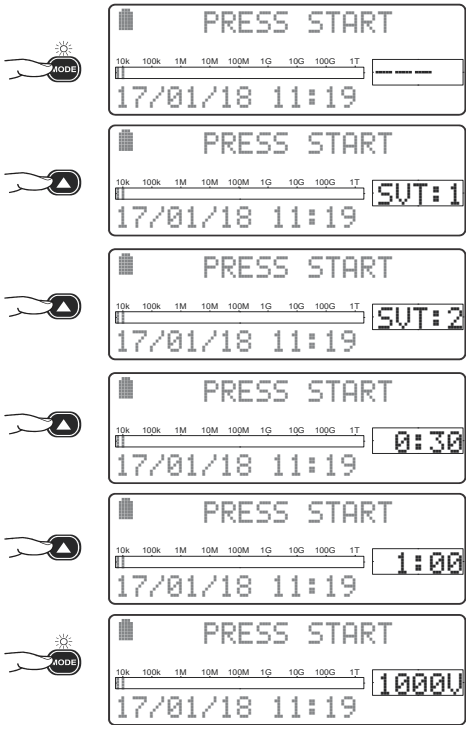
Note: Test voltage is the only parameter that can be modified during tests.

5.2. Selection of the operation mode

The **INS-5005kV** insulation tester has five operation modes: Normal, with "TIMER", SVT1, SVT2 and "Pass / Fail test". The first four modes are selected using the MODE key; the "Pass/ Fail test" mode is activated pressing LIM key.

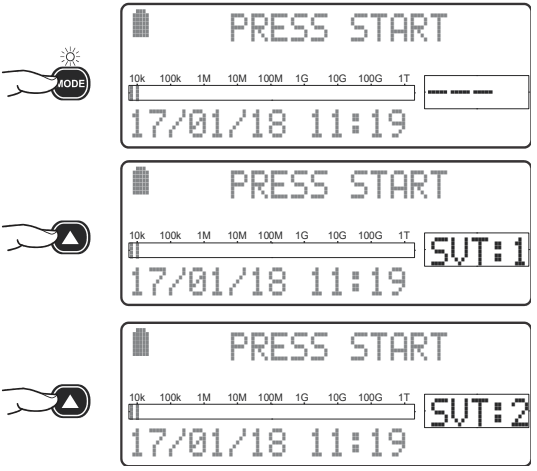
5.2.1. "TIMER" Mode

The use of MODE key allows the **INS-5005kV** setting for the performance of a pre-set - duration test; when this mode is selected, the display shows the programmed time. Use ▲ and ▼ keys to define the duration of the tests in 30 seconds, 1 minute, 3 minutes, 10 minutes, 30 minutes or 90 minutes.



5.2.2. SVT Mode (step voltage tests)

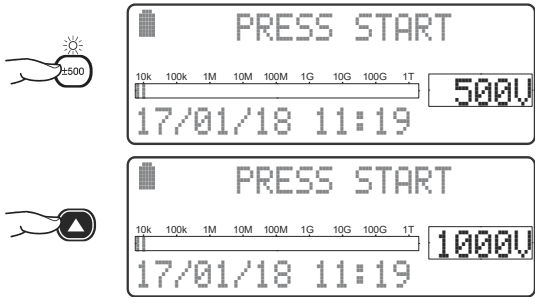
The use of MODE key allows the **INS-5005kV** setting for the performance of a step voltage test type 1 or type 2; when this mode is selected, the display shows the **SVT:1** or **SVT:2** abbreviation.



SVT:1 Mode

Under this operation mode, the user does not define a specific voltage test, but a maximum voltage value. The device will start the test applying a 500 V voltage and increase this value in 500 V steps each minute until reaching the programmed voltage. At each stage, the **INS-5005kV** measures the resistance before advancing towards the following step.

The use of voltage adjusting keys, determines the value of the highest voltage – which will be, in all cases, a multiple of 500 V, up to a 5000 V limit. It is advisable to use the ±500 V key in order to select this value; ±100 V key may be used, but if the selected value is not a multiple of 500, it will be rounded down.



SVT:2 Mode

In this mode, if the maximum voltage value is set to 2500 V or lower, the test will perform the same way as SVT:1 mode.

If the maximum voltage is set to a higher value than 2500 V, the test will always perform 5 steps with one minute duration each. The step voltage value will be the defined max. voltage divided by 5.

Example: if the max. voltage is set to 3000 V, the step voltage will be 600 V.

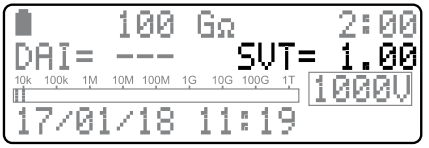
SVT test result

The test result is calculated according to the following formula:

$$SVT = \frac{R_{V\,MAX}}{R_{500}}$$

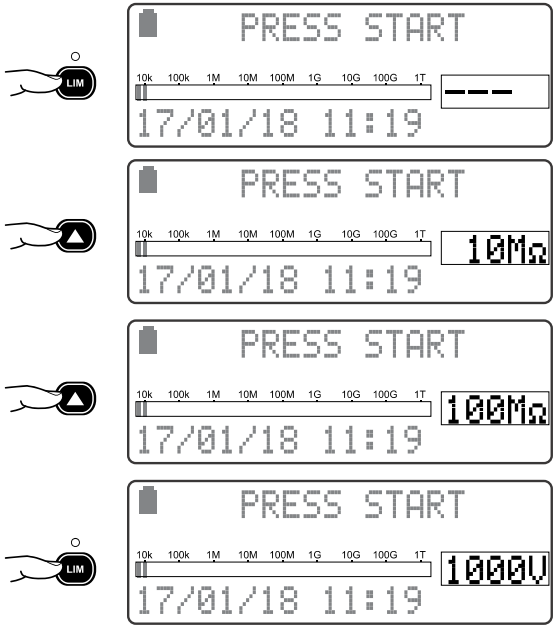
After test ending, the value may be recovered by pressing 

key.



5.2.3. “Pass / Fail” Test mode

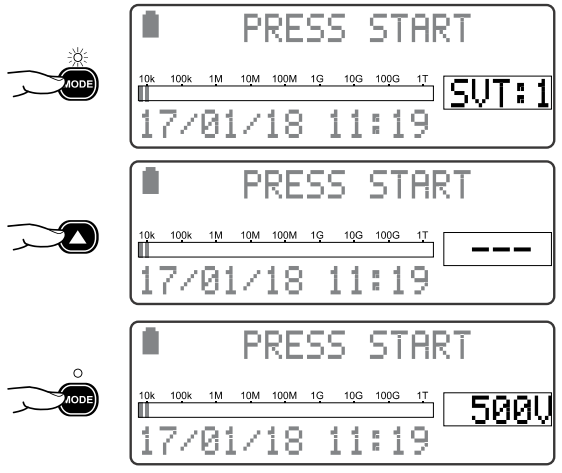
Press LIM key in order to determine the lower insulation limit for type “Pass / Fail test”. Select this value using ▲ and ▼ keys. Possible values are 10 MΩ, 100 MΩ, 1 GΩ or 10 GΩ.



During a “Pass/ Fail test”, the **INS-5005kV** will indicate when the insulation resistance is lower than the programmed limit, with an intermittent beep and the LIM key LED flashing. The LIM key LED will remain flashing until the end of tests, or until the measurement of the resistance value is greater than the programmed limit.

5.2.4. Normal mode

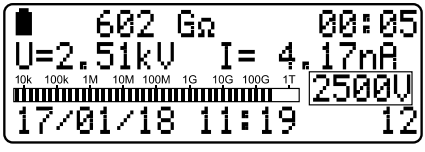
The normal mode is used in the resistance measurement with unique voltage, without time limit. When selected, there are no special indications in the display. To return to normal mode, press the MODE key and use the ▲ or ▼ to select the "**- - -**" option.



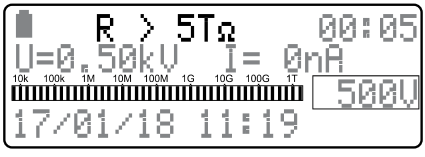
6. How to perform tests

ATTENTION: Please, never connect or disconnect the test leads with the equipment under operation or while the High Voltage LED is on. If there is a need to modify the connections, this should be done with the equipment powered-off and with discharged potentials (High Voltage LED off)

Press (START) key. The **high voltage LED** turns on immediately, indicating that the equipment internal generator is applying voltage to the element that is being tested. The display will show the test number, the selected voltage value and it will start the elapsed time count. For a few seconds, the auto-range system will search for the most convenient range for the value being measured. If the measured value is within the device range, the display will show the resistance value indication and its corresponding unit, and it will start the analogue bargraph indication.



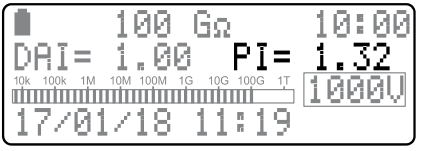
If the measured value exceeds 5 TΩ @ 5 kV, the following message will be read:



Note: If, during the test, it is necessary to change the test voltage, item sequence shall be repeated

6.1. Polarization index (PI)

The PI/DAI SVT key makes it possible to visualize the Polarization Index value on the display. For this type of test, the equipment must be connected and applying voltage to the sample for 10 minutes. After this period, the operator must press the PI/DAI SVT key to show the PI value on the instrument display. If the key is pressed before the 10-min period has elapsed, the display will show PI= - - -.

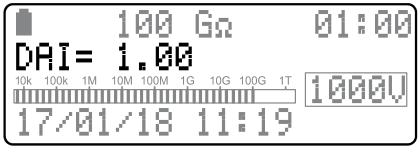


The polarization index is the ratio between the insulation resistance value measured after 10 min and the value measured after 1 min. This index is useful to determine whether it is necessary to perform preventive and predictive Maintenance in order to detect any insulation resistance wear and tear due to the excess of dust, dirt, grease, or else the action of chemical or physical agents, etc.

$$PI = \frac{R_{10\ minutes}}{R_{1\ minute}}$$

6.2. Dielectric Absorption Index (DAI)

The PI/DAI SVT key makes it possible to visualize the Dielectric Absorption Index value on the display. For this kind of test, the equipment should be connected, applying voltage to the sample for 60 seconds. After this period, the operator must press the PI/DAI SVT key to read the absorption index value on the display. If this key is pressed before the 1-minute period has elapsed, the display will show DAI = - - -.



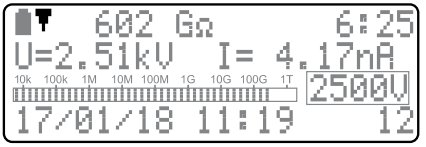
The Dielectric Absorption Index is the ratio between the insulation resistance value measured after 60 seconds and the value measured after 30 seconds. This value is useful to determine whether it is necessary to perform preventive and predictive maintenance on the coils (transformers, engines and motors, generators, etc.).

$$DAI = \frac{R_{60\ seconds}}{R_{30\ seconds}}$$

7. Other functions

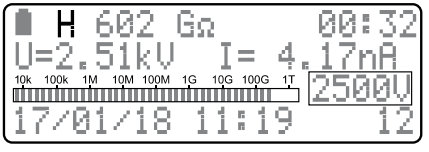
7.1. Filter

When insulation measures are carried out in transformers or in large dimension machines, in presence of strong electromagnetic fields, it is possible that the equipment reading is unstable, especially for resistance values higher than 100 MΩ. In these cases it is convenient to press the (FILTER) key. This function allows to reach the insulation resistance value in an upward curve without significant oscillations.



7.2. Hold

The (HOLD) key allows to hold the last performed reading on the display, at the moment this key was pressed, without interrupting the test. When this key is pressed again, the equipment updates the resistance and time values. The (HOLD) key led and the letter **H** on the display indicates that the function was activated.



7.3. Internal memory

This equipment has an internal memory for up to 4000 measured values. This memory is administrated by the instrument and works in a cyclic way, this means, when the memory is full, the oldest values in the memory will be replaced by the newest ones. To avoid lost of data, always download the internal memory after finish the measurements.

7.3.1. Auto power-off

The Auto-power-off function turns off the equipment consumption (independently of the timer function) in two situations:

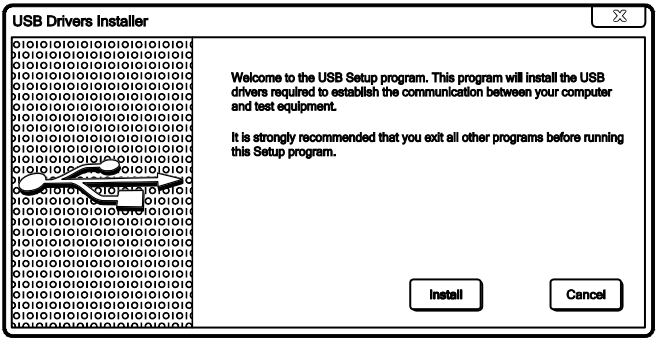
- **During the measurement** - After 35 minutes of measuring without pressing any button.
- **Idle equipment** - After 10 minutes of inactivity.

8. Software

8.1. USB Drivers

To install the USB drivers required for the communication between PC and equipment follow the instructions:

1. Connect the equipment in the PC using the USB cable.
2. If there is an available Internet connection, Windows will silently connect to the Windows Update website and install any suitable driver it finds for the device. If no suitable driver is automatically found then you need to insert the CD-ROM, supplied with the equipment, in the PC, run the executable "**usb-install.exe**" and click in "**Install**".



8.2. Tinsley Software

This software makes communication between the equipment and a computer with Windows operative system easier. It makes possible to synchronize the date and time of the equipment internal clock with the computer date and clock, to transfer the stored date, to clear the memory, to generate test graphics and protocols, etc.

9. Printer

In order to enable the printing function press  key before starting a measurement. Measured values will be printed each 15 seconds, and the Dielectric Absorption Index and Polarization Index will be printed after 1 minute and 10 minutes respectively.

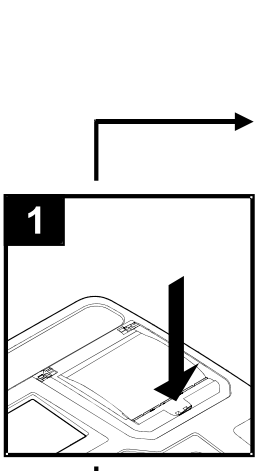
This printer uses 2.2” (57 mm) - wide thermal paper, which comes in a 1.18” (30 mm)-diameter reel.

9.1. Replacing the paper roll – quick replacement procedure

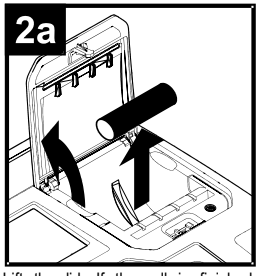
The following procedure demonstrates how to quickly replace the paper roll (No tool required).

Precautions

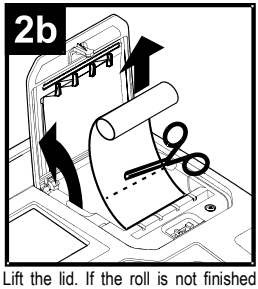
- Perform the following procedure with the equipment **POWERED ON** (battery supplied).
- To eliminate electrical hazards, disconnect the equipment from the main supply, remove the AC Adapter and disconnect the test leads.



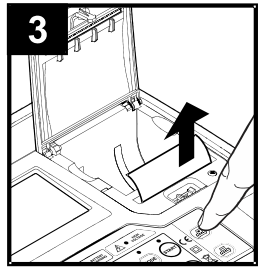
To unlock the printer lid, press the area marked with “PUSH”.



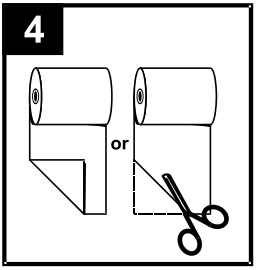
Lift the lid. If the roll is finished, remove the empty roll.



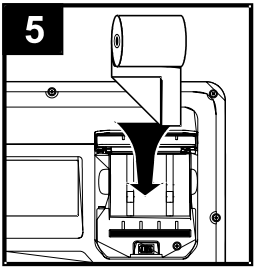
Lift the lid. If the roll is not finished and you wish to replace it regardless, cut the paper as indicated and remove the roll.



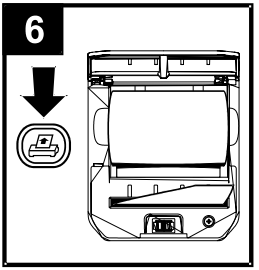
Press the Paper Feed button until the equipment emits a Beep. Then slowly remove the leftover paper.



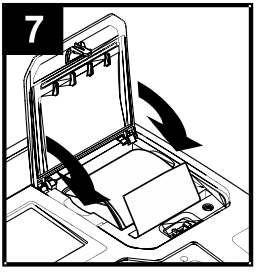
Fold or Cut the paper tip as illustrated.



Insert the paper tip in the aperture located between the paper container and the printer mechanism cover. A sensor will detect the paper and the equipment will emit a Beep.



Press and hold the Paper Feed button until the paper tip appears at the paper output opening and place the paper roll in the paper container.



Close the lid inserting the paper tip in the lid opening.

Troubleshooting

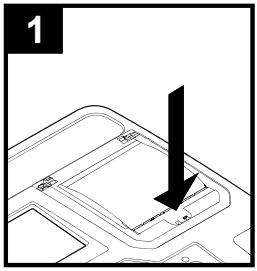
If the printer mechanism is not performing as expected after the quick replacement procedure, check if the printer cylinder is in place by opening the printer mechanism cover. For instructions on how to open the printer mechanism cover, refer to the *9.2 - Replacing the paper roll – complete replacement procedure* on page *31*.

9.2. Replacing the paper roll – complete replacement procedure

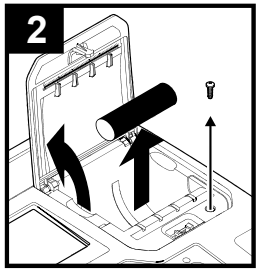
The following procedure demonstrates how to replace the paper roll by removing the printer mechanism cover (Requires a Phillips screwdriver).

Precautions

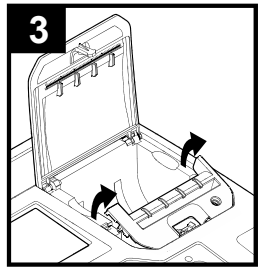
- Perform the following procedure with the equipment **POWERED OFF**.
- ⚠ To eliminate electrical hazards, disconnect the equipment from the main supply, remove the AC Adapter and disconnect the test leads.
- Never operate this equipment without the printer mechanism cover properly placed and fastened with the provided screw.



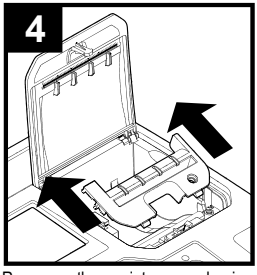
To unlock the printer lid, press the area marked with "PUSH".



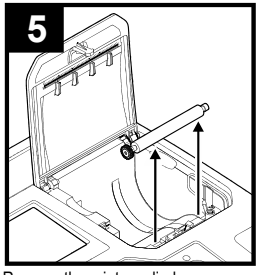
Open the lid, remove the empty roll and gently pull the leftover paper. Remove the screw using a phillips screwdriver.



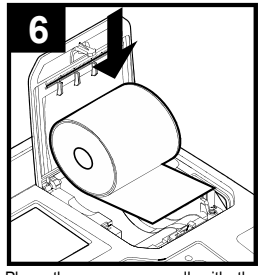
Pull the printer mechanism cover as indicated. Be careful to not damage the snap-fit locks located underneath the cover.



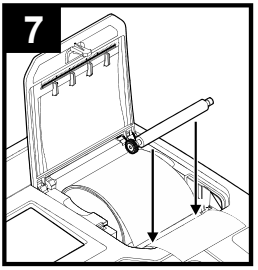
Remove the printer mechanism cover.



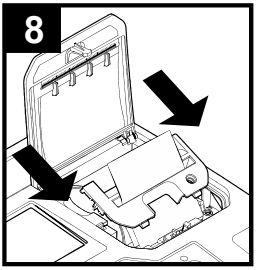
Remove the printer cylinder.



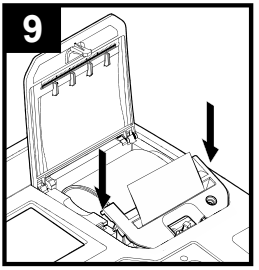
Place the new paper roll with the paper tip facing down.



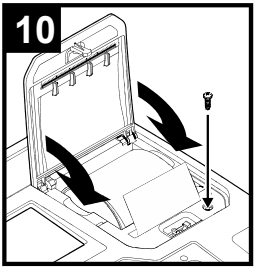
Reposition the printer cylinder. The paper tip must be placed between the printer mechanism header and the cylinder.



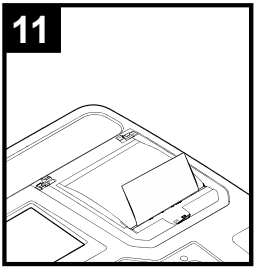
Reinsert printer mechanism cover.



Push the sides of the printer mechanism cover as indicated. Make sure that the cover is aligned and locked in its intended position.



Re-tighten the screw using a Phillips screwdriver. Close the lid inserting the paper tip in the lid opening.



The printer is now ready.

10. Technical specifications

Test voltages	:	500, 1000, 2500, 5000 V with fast selection. 500 V to 5 kV in 100 V or 500 V steps. DC, negative in relation to grounding.
Maximum resistance reading	:	5 TΩ @ 5 kV.
Short circuit current	:	1.5 ± 0.5 mA
Test voltages accuracy	:	± 3% of nominal value over 10 GΩ resistance.
Equipment basic accuracy	:	± 5% of reading from 1 MΩ up to 1 TΩ. ± 20% of reading from 1 TΩ up to 5 TΩ.
Advanced features	:	Automated Polarization Index computing Automated Dielectric Absorption Ratio computing Step Voltage Test Programmable timer. “Pass-fail test” with programmable limits.
Built-in printer (optional)	:	Prints elapsed time, actual voltage applied to the charge and measured resistance.
Interface	:	USB.
Memory up to 4000 measured values	:	It allows for the storage of 4000 tests readings in its internal NVRAM memory.
Built-in chronometer	:	Shows elapsed time since measurement stats in mm:ss format.
Real time clock	:	Indicates date, hour and minutes.
Environmental protection	:	IP54 (with closed lid).
Safety class	:	In accordance with IEC 61010-1.
EMC	:	In accordance with IEC 61326-1.
Electromagnetic irradiation Immunity	:	In accordance with IEC 61000-4-3.
Electrostatic immunity	:	In accordance with IEC 61000-4-2.

Power supply	:	Internal rechargeable battery (LiFePO4 12 V - 3000 mAh) or AC Adapter.
Battery charger	:	12 V - 2.0 A (AC Adapter).
Operating temperature range	:	-5 °C to 50 °C.
Storage temperature range	:	--25 °C to 70 °C.
Humidity range	:	95 % RH (non condensing).
Dimensions	:	274 x 250 x 124 mm.
Equipment weight	:	Approx. 2.7 kg.
Supplied accessories	:	2 Measuring test leads, 1.8 meters 1 Guard test lead, 1.8 meters 1 AC Adapter 1 USB communication cable 1 Tinsley Software user license 1 User guide 1 Carrying bag

Subject to technical change without notice.

11. Application note 32

Use of "Guard" terminal in insulation testers

When insulation resistance measurements are performed with insulation testers, especially with high sensitivity instruments measuring high resistance values, the use of the *GUARD* terminal avoids the harmful influence of stray resistances.

In order to better explain the function of this terminal, let us start reviewing the insulation tester basic circuit diagram of fig. 1.

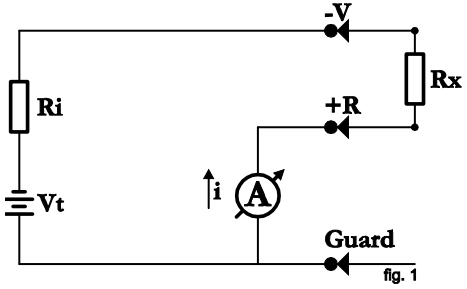


fig. 1

Where:

+V	:	DC high-voltage generator
Ri	:	Generator internal resistance
A	:	Indicator meter (micro-ammeter)

The unknown resistance (Rx) is connected between V and R terminals. Its value determines the current passing through the circuit, which in turn is indicated by the micro-ammeter. The value of Rx can be determined as follows:

$$Rx = \frac{V}{i} - Ri$$

In many cases the resistance to be measured is in parallel with other stray resistances which influence on Rx should be minimized.

A typical example of this situation is when the insulation resistance between primary and secondary windings of a transformer mounted inside a metal housing is to be measured.

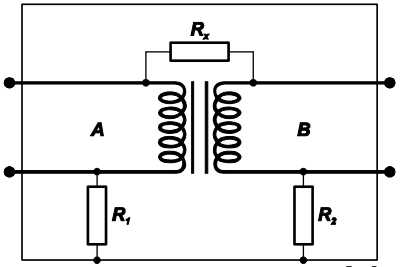


fig. 2

Rx: Insulation resistance between primary and secondary winding.
R1: Insulation resistance between primary winding and housing.
R2: Insulation resistance between secondary winding and housing.

If the insulation tester (terminals V and R) is connected to transformer terminals A and B, and considering that the resistance of the coils on each side of the transformer may be disregarded, Rx appears to be in parallel with (R1 + R2). The situation is changed if we connect the transformer housing to GUARD terminal. Then the circuit will be:

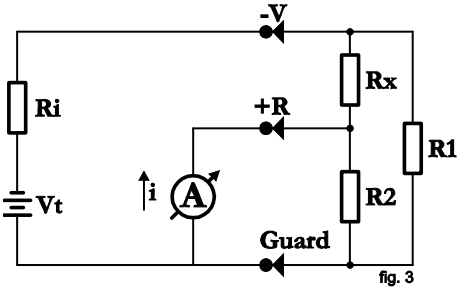


fig. 3

In the circuit of Fig. 3 it may be noted that R1 is in parallel with a low-value resistance (the one from the micro-ammeter) therefore its influence is reduced during reading.

Through resistance R2 circulates a current which is not passing through the meter and consequently does not affect the reading. In fact, current through R2 originates a certain error, since it creates an additional voltage drop in R1 which was not regarded during equipment calibration. As regards the practical use of instrument, it shall be considered that if R1 and R2 are higher than 100 MΩ, any value of Rx will be measured with an insignificant error. For example: Let us consider Rx = 3000 MΩ and R1 = R2 = 100 MΩ, the reading without using the GUARD terminal would be 187.5 MΩ, which is quite wrong. On the other hand, if the GUARD terminal is properly used, we would have 3000 MΩ.

Notes